# Route 460 Location Study

# AIR QUALITY

# TECHNICAL REPORT

**May 2005**

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# 1.0 AFFECTED ENVIRONMENT

## 1.1 AIR QUALITY

This section presents applicable federal air quality standards and discusses whether the Route 460 Location Study attains those standards. Air quality is a general term used to describe the pollutant levels in the atmosphere. The air quality analysis will identify the potential air quality effects associated with traffic conditions resulting from the construction of the proposed Route 460 alternatives.

## 1.2 REGULATORY CONTEXT

In accordance with the Clean Air Act of 1970 (42 USC 7609, as amended in 1997 and 1990) the US Environmental Protection Agency (EPA) established National Ambient Air Quality Standards (NAAQS) for six major pollutants. These include: carbon monoxide (CO), lead (Pb), nitrogen oxides ($NO_x$), ozone ($O_3$), particulate matter ($PM_{10}$ and $PM_{2.5}$), and sulfur oxides ($SO_x$). These standards, presented in Table 1.2-1, are also the official ambient air quality standards for the State of Virginia. The "primary" standards have been established to protect the public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. The "secondary" standards are intended to protect the nation's welfare and account for air pollutant effects on soil, water, visibility, materials, vegetation, and other aspects of the general welfare. Of these six pollutants, the FHWA requires a detailed evaluation of CO.

**Table 1.2-1**
**NATIONAL AMBIENT AIR QUALITY STANDARDS**

| Pollutant | Primary Standards | Averaging Times | Secondary Standards |
|---|---|---|---|
| Carbon Monoxide | 35 ppm (40 mg/m$^3$)$^C$ | 1-hour | None |
| | 9 ppm (10 mg/m$^3$)$^C$ | 8-hour | None |
| Lead | 1.5 µg/m$^3$ | Quarterly Average | Same as Primary |
| Nitrogen Dioxide | 0.053 ppm (100 µg/m$^3$) | Annual ( Arithmetic Mean) | Same as Primary |
| Particulate Matter (PM10) | 50 µg/m$^3$ | Annual ( Arithmetic Mean) | Same as Primary |
| | 150 µg/m$^3$ $^E$ | 24-hour | Same as Primary |
| Particulate Matter (PM2.5) | 15 µg/m$^3$ $^D$ | Annual ( Arithmetic Mean) | Same as Primary |
| | 65 µg/m$^3$ $^E$ | 24-hour | Same as Primary |
| Ozone | 0.12 ppm (235 µg/m$^3$)$^A$ | 1-hour | Same as Primary |
| | 0.08 ppm (157 µg/m$^3$)$^B$ | 8-hour | Same as Primary |
| Sulfur Oxides | 80 µg/m$^3$ (0.3 ppm)$^C$ | Annual ( Arithmetic Mean) | - - |
| | 365 µg/m$^3$ (0.14 ppm)$^C$ | 24-hour | - - |
| | - - | 3-hour | 1300 µg/m$^3$ (0.5 ppm)$^C$ |

Source: USEPA, "National Primary and Secondary Ambient Air Quality Standards." (49 CFR 50).

Notes:
A Areas not attaining the 1-hour standard by the end of 1997 must attain that standard before demonstrating attainment with the 8-hour standard.
B 3-year average of the 4$^{th}$ highest 8-hour concentration may not exceed 0.08 ppm.
C Not to be exceeded more than once a year.
D Based on a 3-year average of annual averages.
E Based on a 3-year average of annual 98th percentile values.
Abbreviations: ppm - parts per million µg/m$^3$ - micrograms per cubic meter mg/m$^3$ - milligrams per cubic meter

## 1.3 CARBON MONOXIDE

Carbon Monoxide is a colorless, odorless, poisonous gas formed from the incomplete combustion of fossil fuels. It is the primary pollutant emitted from automobiles and contributes about 60 percent of all CO emissions nationwide and is the major source of CO in the study area.

The state and federal ambient air quality standards for carbon monoxide are as follows:

- 1-hour - 35 parts per million (ppm) or 40 milligrams per cubic meter ($mg/m^3$); not to be exceeded more than once per year;
- 8-hour - 9 ppm or 10 $mg/m^3$; not to be exceeded more than once per year.

Any 1-hour concentration above 35 ppm or 8-hour concentration above 9 ppm is considered a violation of the standards.

In order to determine potential CO concentrations at receptors near a highway, two concentration components must be used: local and background. The local component takes into account CO emitted by cars operating on highways near receptors (i.e., within 300 feet). The background component takes into account CO emitted by cars operating on streets further from receptor locations. The background CO concentration for the project area is estimated to be 6.0 parts per million (ppm) for the one-hour period and 3.0 ppm for the eight-hour period. Consultation with the Air, Noise and Energy Section, Environmental Division, Virginia Department of Transportation, indicated that an ambient CO concentration of 3.0 ppm is applied to most rural areas.

## 1.4 OTHER EMISSIONS

Automobiles also are sources of hydrocarbons and nitrogen oxides. Hydrocarbons and nitrogen oxides emitted from cars in an urban area are mixed together in the atmosphere where they react with sunlight to form ozone, nitrogen dioxide, and other photochemical oxidants. It is the photochemical oxidants that are of concern and not the precursor hydrocarbons and nitrogen oxides.

The photochemical reactions that form ozone and nitrogen dioxide require several hours to occur. For this reason, the peak levels of ozone generally occur 6 to 12 miles (10 to 20 kilometers) downwind of the source of pollutant emissions and urban areas as a whole are regarded as sources of photochemical oxidants, not individual streets and highways. The best example of this type of air pollution is the smog that forms in Los Angeles, California.

Area-wide automotive emissions of hydrocarbons and nitrogen oxides are expected to decrease in the future because of the continued installation and maintenance of pollution control devices on new cars. No appreciable changes in these emissions are expected on Route 460.

Automobiles are not significant sources of particulate matter and sulfur dioxide. Nationwide, highway sources account for less than seven percent of particulate matter emissions and less than two percent of sulfur dioxide emissions. Particulate matter and sulfur dioxide emissions are predominantly the result of non-highway sources (e.g., industrial, commercial, and agricultural activities). Because emissions of particulate matter and sulfur dioxide from cars are very low, there is no reason to suspect that traffic on Route 460 would cause air quality standards for particulate matter and sulfur dioxide to be exceeded.

Automobiles emit lead as a result of burning gasoline containing tetraethyl lead, which is added by refineries to increase the octane rating of the fuel. In 1973, the EPA called for a reduction in the lead content of leaded gasoline. The average lead content of gasoline in 1973 was 2-3 grams per gallon or about 200,000 tons of lead a year. In 1975, passenger cars and light trucks were manufactured with more elaborate emission control system which included catalytic converters that required unleaded gasoline and emit no lead. By 1989, the composite average of lead in gasoline had dropped to 0.01 grams per gallon. In 1995, leaded fuel accounted for only 0.6 percent of total gasoline sales or less than 2,000 tons per year. Effective January 1, 1996, the Clean Air Act banned the sale of the small amount of leaded fuel that was still available in some parts of the country for use in on-road vehicles. Because of these reasons, the traffic on Route 460 would not cause the NAAQS for lead to be exceeded.

## 1.5 EXISTING AIR QUALITY LEVELS AND COMPLIANCE IN THE STUDY AREA

Section 107 of the 1997 Clean Air Act Amendments requires the EPA to publish a list of all geographic areas in compliance with the NAAQS, as well as those not in attainment of the NAAQS. Areas not in compliance with the NAAQS are termed non-attainment areas. The designation of an area is made on a pollutant-by-pollutant basis. In July of 1997, EPA adopted an 8-hour standard for $O_3$ (0.08 ppm) and added $PM_{2.5}$ as a criterion pollutant to the NAAQS.

EPA evaluated the latest scientific data and developed a standard more protective of public health after discovering that adverse health effects resulting from ozone exposure occur at lower concentrations spread out over longer periods of time. However, before EPA could apply the new 8-hour standard for ozone, it was tied up in litigation. Finally, in spring of 2004, EPA designated areas in nonattainment with the 8-hour standard. Areas designated nonattainment under the 8-hour ozone standard have one year to demonstrate conformity in accordance with the procedures established by EPA at which time the 1-hour ozone standard will be revoked.

In July of 1997, EPA added $PM_{2.5}$ as a criterion pollutant to the NAAQS. EPA designated $PM_{2.5}$ nonattainment areas on January 5, 2005. Only the northern Virginia area has been designated as a PM2.5 nonattainment area.

The study area is currently classified as being in attainment of all NAAQS pollutants except for the one-hour and eight hour $O_3$ standard. The study area lies between two nonattainment areas and as such is classified as maintenance or marginal nonattainment area depending on the county. The City of Suffolk is classified as a maintenance area for one-hour $O_3$ and as a marginal area for the eight-hour $O_3$ standard. Isle of Wight and Prince George Counties are also classified as a marginal area for the eight-hour $O_3$ standard. A maintenance area is defined as an area that was once classified as a nonattainment area but has shown, through monitored data, now to be in attainment of the applicable standard. Marginal areas are based on the 8-hour design value calculated using the most recent three years of monitored data. Marginal areas must attain national air quality standards for eight-hour $O_3$ no later than June 2007. Regardless of its classification, the City of Suffolk, Isle of Wight, and Prince George Counties are all subject to the requirements of the EPA's Transportation Conformity Rule.

While a network of sampling stations monitors air pollutant levels throughout Virginia, currently there are no monitoring stations located within the study area. The closest monitoring stations are located in the City of Suffolk (Station 183-F) and Charles City County (Station 75-B). These monitoring stations, under the supervision of the Virginia Department of Environmental Quality (DEQ), measure for $O_3$, $NO_2$, $SO_2$ and $PM_{2.5}$. According to the *Virginia Ambient Air Monitoring 2003 Data Report,* the one-hour $O_3$ criteria (.12 ppm) was exceed at the Charles City County monitoring station and the eight-hour $O_3$ criteria (.08 ppm) was exceeded at both the City of Suffolk and the Charles City County monitoring stations.

# 2.0 ENVIRONMENTAL CONSEQUENCES

## 2.1 AIR QUALITY

A microscale air quality analysis was conducted to determine the potential effects of the Candidate Build Alternatives (CBAs) on local air quality. The "worst-case" project level carbon monoxide (CO) concentrations were determined for the existing (2003), interim (2015), and design (2026) years. These CO concentrations were then compared to the National Ambient Air Quality Standards (NAAQS). The maximum one-hour and eight-hour CO levels predicted were below NAAQS maximum levels, thus, the proposed Route 460 Location Study would not cause a violation of the NAAQS. The project conforms to the State Implementation Plan (SIP) and the goals set forth in the Clean Air Act Amendments (CAAA) and the Final Conformity Rule.

## 2.2 METHODOLOGY

Microscale air quality modeling was performed using EPA's CAL3QHC program. Input emission factors were based on the EPA mobile source emission factor model (MOBILE 6.2). These emission factors are shown in Appendix A. Dispersion parameters within the program are based on EPA's CALINE3 air quality dispersion model. Following the guidelines set forth in VDOT's Project *Air Quality Analysis Consultants Guide, Revision 13,* CO levels in the study area were estimated for each CBA, including the existing and No-Build scenarios. Sites were selected based on worst-case existing and estimated future traffic conditions and their location relative to the alignment where the highest CO concentrations could be expected and where the general public would have access during the analysis periods (i.e. sidewalks and bike lanes).

Maximum one-hour and eight-hour CO levels were estimated for each CBA for the existing year (2003), interim or completion year (2015 Build and No-Build scenarios) and the design year (2026 Build and No-Build scenarios).

Microscale modeling is used to predict CO concentrations resulting from emissions from motor vehicles using roadways immediately adjacent to the location at which predictions are being made. A CO "background level" must be added to this value to account for CO entering the area from environmental and other non-mobile sources upwind of the receptors. Based upon VDOT recommendations, a one-hour background and eight-hour background concentrations of 6 ppm and 3 ppm, respectively, were applied to all analysis sites.

Traffic data used for the air quality analysis was developed as part of an overall traffic analysis for this study. The microscale CO analysis was performed for the peak one-hour and eight-hour standard. These are the periods when the greatest air quality effects of the proposed project are expected. The average number of vehicles per hour during the peak eight-hour period was calculated as 0.6 percent of the average daily traffic. The persistence factor was recommended by VDOT and is based on guidance in FHWA's *Manual for Air Quality Considerations in Environmental Documents*.

## 2.3 IMPACTS

Maximum one-hour and eight-hour CO levels predicted for each CBA are shown in Table 2.3-1 and Table 2.3-2 respectively. These tables also include the predicted CO levels expected to occur under the existing and No-Build condition. All predicted concentrations are below the applicable Federal Standards. The CAL3QHC model results are shown in Appendix B.

**Table 2.3-1**
**ONE HOUR PREDICTED CO CONCENTRATIONS (PPM)**

| CBA | Location | | Existing (2003) | No-Build (2026) | Interim (2015) | Build (2026) |
|---|---|---|---|---|---|---|
| | From | To | | | | |
| 1 | Proposed Interchange at US 258, in Windsor | Eastern Terminus at US 58 Bypass | 10.2 | 8.3 | 6.8 | 7.3 |
| 2 | Proposed Interchange at Route 460 East of Windsor | Eastern Terminus at US 58 Bypass | 10.2 | 8.3 | 6.8 | 7.1 |
| 3 | Proposed Interchange at Route 460 East of Windsor | Eastern Terminus at US 58 Bypass | 10.2 | 8.3 | 6.9 | 7.4 |

**Table 2.3-2**
**EIGHT HOUR PREDICTED CO CONCENTRATIONS (PPM)**

| CBA | Location | | Existing (2003) | No-Build (2026) | Interim (2015) | Build (2026) |
|---|---|---|---|---|---|---|
| | From | To | | | | |
| 1 | Proposed Interchange at US 258, in Windsor | Eastern Terminus at US 58 Bypass | 5.5 | 4.4 | 3.5 | 3.8 |
| 2 | Proposed Interchange at Route 460 East of Windsor | Eastern Terminus at US 58 Bypass | 5.5 | 4.4 | 3.5 | 3.7 |
| 3 | Proposed Interchange at Route 460 East of Windsor | Eastern Terminus at US 58 Bypass | 5.5 | 4.4 | 3.5 | 3.8 |

The highest predicted one-hour and eight-hour CO concentrations occur along CBA 1 between the City of Windsor and the US 58 Bypass at eastern terminus of the project. This location also has the highest hourly volume of vehicles (over 3,400 in all future scenarios) of all sites analyzed. Recognizing that the predicted concentrations of CO include background concentrations of 3 and 6 ppm for the eight- and one-hour levels, respectively, the proposed project will have little effect on existing levels of localized pollution. The CO concentrations for each CBA will decrease in the design year compared to the existing conditions and are well below the NAAQS for CO for each CBA

## 2.4 CONSTRUCTION IMPACTS

The temporary air quality impacts from construction are not expected to be significant. Construction activities are to be performed in accordance with VDOT's *Road and Bridge Specifications*. The Specifications are approved as conforming to the State Implementation Plan (SIP) and require compliance with all applicable local, state, and federal regulations.

## 2.5 PROJECT-LEVEL CONFORMITY

The purpose and need of the study focuses on meeting the current and future regional transportation needs of the area. The Route 460 Location Study is currently included for construction in the constrained Long-Range Plan for the Hampton Roads and Richmond/Petersburg regions, and the plan has been found to conform to the SIP under the 1-hour ozone standard by FHWA and FTA. No phase of the project is currently included in either region's Transportation Improvement Program with the exception of preliminary engineering and the environmental study.

# 3.0 REFERENCES


Clean Air Act Amendments (CAAA). 40CFR Part 50-87.

United States Environmental Protection Agency, “National Primary and Secondary Ambient Air Quality Standards.” (49 CFR 50).

US Department of Transportation, Federal Highway Administration, “23 CFR Part 772: Procedures for Abatement of Highway Traffic Noise and Construction Noise B Final Rule.” Federal Register, Vol. 47, No. 131, 8 July 1982.

US Department of Transportation, Federal Highway Administration Southern Resource Center, Manual for Air Quality Considerations in Environmental Documents.

Virginia Department of Environmental Quality, Virginia Ambient Air Monitoring 2002 Data Report, June 2003.

Virginia Department of Transportation, Air, Noise, and Energy Section, Project Air Quality Analysis Consultants Guide, Revision 13, August 11, 2004.

Virginia Department of Transportation, Road and Bridge Specifications, Section 107.14(b) 2 Air, 2002

# APPENDIX A
# MOBILE 6.2 Emission Factors

# Route 460 Location Study

# AIR QUALITY
# Technical Report

**Existing Year (2003)**
**Carbon Monoxide**

| Avg. Speed | Rural Int. | Urban Int. | Freeway | U Prin Art | R Prin Art | U Minor Art | R Minor Art | Collectors |
|---|---|---|---|---|---|---|---|---|
| 2.5 | 65.772 | 68.597 | 70.72 | 73.258 | 70.07 | 73.25 | 72.055 | 71.922 |
| 3 | 61.287 | 63.824 | 65.732 | 64.304 | 61.697 | 64.298 | 63.321 | 63.212 |
| 4 | 51.181 | 53.07 | 54.491 | 53.112 | 51.232 | 53.107 | 52.403 | 52.325 |
| 5 | 45.117 | 46.617 | 47.746 | 46.396 | 44.952 | 46.393 | 45.852 | 45.793 |
| 6 | 40.884 | 42.223 | 43.231 | 42.326 | 40.951 | 42.319 | 41.806 | 41.743 |
| 7 | 37.765 | 39.038 | 39.997 | 39.418 | 38.093 | 39.409 | 38.915 | 38.851 |
| 8 | 35.426 | 36.65 | 37.572 | 37.238 | 35.949 | 37.227 | 36.748 | 36.681 |
| 9 | 33.607 | 34.792 | 35.685 | 35.542 | 34.282 | 35.53 | 35.062 | 34.994 |
| 10 | 32.151 | 33.306 | 34.176 | 34.185 | 32.948 | 34.172 | 33.713 | 33.644 |
| 11 | 30.999 | 32.157 | 33.029 | 33.243 | 31.946 | 33.228 | 32.747 | 32.673 |
| 12 | 30.091 | 31.292 | 32.197 | 32.458 | 31.11 | 32.441 | 31.942 | 31.864 |
| 13 | 29.324 | 30.56 | 31.492 | 31.793 | 30.403 | 31.775 | 31.261 | 31.179 |
| 14 | 28.665 | 29.933 | 30.889 | 31.224 | 29.797 | 31.205 | 30.678 | 30.592 |
| 15 | 28.095 | 29.39 | 30.365 | 30.73 | 29.272 | 30.71 | 30.172 | 30.084 |
| 16 | 27.652 | 28.98 | 29.981 | 30.291 | 28.791 | 30.27 | 29.716 | 29.625 |
| 17 | 27.393 | 28.773 | 29.813 | 29.904 | 28.366 | 29.882 | 29.315 | 29.221 |
| 18 | 27.162 | 28.589 | 29.663 | 29.56 | 27.988 | 29.537 | 28.957 | 28.861 |
| 19 | 26.956 | 28.424 | 29.529 | 29.252 | 27.65 | 29.229 | 28.638 | 28.54 |
| 20 | 26.77 | 28.275 | 29.409 | 28.974 | 27.346 | 28.951 | 28.35 | 28.25 |
| 21 | 26.601 | 28.14 | 29.3 | 28.748 | 27.091 | 28.724 | 28.113 | 28.011 |
| 22 | 26.445 | 28.016 | 29.2 | 28.543 | 26.86 | 28.518 | 27.897 | 27.793 |
| 23 | 26.301 | 27.902 | 29.109 | 28.355 | 26.648 | 28.33 | 27.7 | 27.594 |
| 24 | 26.17 | 27.798 | 29.025 | 28.183 | 26.454 | 28.157 | 27.52 | 27.412 |
| 25 | 26.05 | 27.703 | 28.948 | 28.024 | 26.276 | 27.998 | 27.353 | 27.245 |
| 26 | 25.94 | 27.615 | 28.877 | 27.921 | 26.152 | 27.895 | 27.242 | 27.132 |
| 27 | 25.839 | 27.535 | 28.812 | 27.826 | 26.037 | 27.799 | 27.139 | 27.028 |
| 28 | 25.746 | 27.46 | 28.752 | 27.737 | 25.93 | 27.71 | 27.044 | 26.931 |
| 29 | 26.774 | 27.391 | 28.695 | 27.654 | 25.831 | 27.627 | 26.955 | 26.841 |
| 30 | 25.579 | 27.326 | 28.643 | 27.577 | 25.739 | 27.55 | 26.872 | 26.756 |
| 31 | 25.548 | 27.312 | 28.642 | 27.592 | 25.734 | 27.563 | 26.879 | 26.762 |
| 32 | 25.539 | 27.321 | 28.663 | 27.605 | 25.729 | 27.576 | 26.885 | 26.767 |
| 33 | 25.531 | 27.329 | 28.683 | 27.618 | 25.725 | 27.589 | 26.891 | 26.772 |
| 34 | 25.523 | 27.336 | 28.702 | 27.63 | 25.721 | 27.6 | 26.897 | 26.776 |
| 35 | 25.52 | 27.348 | 28.725 | 27.641 | 25.717 | 27.611 | 26.902 | 26.781 |
| 36 | 25.65 | 27.501 | 28.895 | 27.808 | 25.86 | 27.778 | 27.06 | 26.937 |
| 37 | 25.774 | 27.646 | 29.056 | 27.967 | 25.995 | 27.937 | 27.21 | 27.085 |
| 38 | 25.89 | 27.783 | 29.209 | 28.117 | 26.123 | 28.086 | 27.352 | 27.225 |
| 39 | 26.001 | 27.913 | 29.354 | 28.26 | 26.245 | 28.229 | 27.486 | 27.358 |
| 40 | 26.127 | 28.057 | 29.512 | 28.396 | 26.36 | 28.364 | 27.614 | 27.484 |
| 41 | 26.268 | 28.215 | 29.682 | 28.564 | 26.51 | 28.532 | 27.776 | 27.644 |
| 42 | 26.402 | 28.366 | 29.845 | 28.725 | 26.654 | 28.692 | 27.929 | 27.797 |
| 43 | 26.53 | 28.509 | 30 | 28.878 | 26.79 | 28.845 | 28.076 | 27.943 |

**Existing Year (2003)**
**Carbon Monoxide**

| Avg. Speed | Rural Int. | Urban Int. | Freeway | U Prin Art | R Prin Art | U Minor Art | R Minor Art | Collectors |
|---|---|---|---|---|---|---|---|---|
| 44 | 26.654 | 28.648 | 30.15 | 29.025 | 26.92 | 28.991 | 28.216 | 28.082 |
| 45 | 26.811 | 28.818 | 30.329 | 29.165 | 27.045 | 29.131 | 28.35 | 28.214 |
| 46 | 26.961 | 28.98 | 30.501 | 29.335 | 27.202 | 29.301 | 28.515 | 28.378 |
| 47 | 27.105 | 29.136 | 30.665 | 29.497 | 27.352 | 29.463 | 28.673 | 28.535 |
| 48 | 27.243 | 29.284 | 30.822 | 29.653 | 27.496 | 29.619 | 28.825 | 28.686 |
| 49 | 27.406 | 29.455 | 30.999 | 29.803 | 27.635 | 29.768 | 28.97 | 28.83 |
| 50 | 27.573 | 29.629 | 31.178 | 29.947 | 27.767 | 29.912 | 29.109 | 28.969 |
| 51 | 27.734 | 29.797 | 31.351 | 30.118 | 27.932 | 30.083 | 29.278 | 29.137 |
| 52 | 27.889 | 29.958 | 31.517 | 30.284 | 28.09 | 30.248 | 29.441 | 29.299 |
| 53 | 28.061 | 30.133 | 31.693 | 30.442 | 28.242 | 30.407 | 29.597 | 29.455 |
| 54 | 28.252 | 30.322 | 31.882 | 30.595 | 28.389 | 30.56 | 29.747 | 29.605 |
| 55 | 28.435 | 30.505 | 32.064 | 30.743 | 28.53 | 30.707 | 29.892 | 29.749 |
| 56 | 28.613 | 30.682 | 32.24 | 30.92 | 28.707 | 30.885 | 30.07 | 29.928 |
| 57 | 28.801 | 30.866 | 32.42 | 31.091 | 28.877 | 31.057 | 30.241 | 30.101 |
| 58 | 29.018 | 31.072 | 32.618 | 31.256 | 29.042 | 31.222 | 30.406 | 30.267 |
| 59 | 29.227 | 31.271 | 32.809 | 31.415 | 29.201 | 31.383 | 30.566 | 30.428 |
| 60 | 29.43 | 31.463 | 32.994 | 31.569 | 29.354 | 31.538 | 30.72 | 30.584 |
| 61 | 29.573 | 31.6 | 33.125 | 31.75 | 29.544 | 31.719 | 30.905 | 30.771 |
| 62 | 29.573 | 31.6 | 33.125 | 31.925 | 29.728 | 31.895 | 31.084 | 30.952 |
| 63 | 29.573 | 31.6 | 33.125 | 32.095 | 29.907 | 32.066 | 31.257 | 31.127 |
| 64 | 29.573 | 31.6 | 33.125 | 32.259 | 30.079 | 32.231 | 31.425 | 31.296 |
| 65 | 29.573 | 31.6 | 33.125 | 32.418 | 30.247 | 32.391 | 31.588 | 31.461 |

| Interim Year (2015) Carbon Monoxide | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Avg. Speed | Rural Int. | Urban Int. | Freeway | U Prin Art | R Prin Art | U Minor Art | R Minor Art | Collectors |
| 2.5 | 30.787 | 32.294 | 33.417 | 34.734 | 32.946 | 34.769 | 34.08 | 34.069 |
| 3 | 28.86 | 30.243 | 31.276 | 30.879 | 29.349 | 30.909 | 30.32 | 30.31 |
| 4 | 24.516 | 25.623 | 26.45 | 26.06 | 24.853 | 26.083 | 25.619 | 25.611 |
| 5 | 21.909 | 22.851 | 23.554 | 23.169 | 22.156 | 23.188 | 22.799 | 22.791 |
| 6 | 19.995 | 20.857 | 21.501 | 21.283 | 20.322 | 21.296 | 20.929 | 20.915 |
| 7 | 18.541 | 19.361 | 19.974 | 19.935 | 19.012 | 19.945 | 19.594 | 19.574 |
| 8 | 17.45 | 18.238 | 18.829 | 18.924 | 18.029 | 18.931 | 18.592 | 18.569 |
| 9 | 16.601 | 17.365 | 17.938 | 18.138 | 17.265 | 18.143 | 17.813 | 17.787 |
| 10 | 15.922 | 16.667 | 17.225 | 17.51 | 16.654 | 17.512 | 17.19 | 17.161 |
| 11 | 15.37 | 16.109 | 16.663 | 17.016 | 16.147 | 17.017 | 16.69 | 16.659 |
| 12 | 14.915 | 15.663 | 16.224 | 16.604 | 15.725 | 16.604 | 16.274 | 16.24 |
| 13 | 14.53 | 15.285 | 15.852 | 16.256 | 15.368 | 16.255 | 15.922 | 15.885 |
| 14 | 14.199 | 14.962 | 15.534 | 15.958 | 15.062 | 15.955 | 15.62 | 15.582 |
| 15 | 13.913 | 14.681 | 15.258 | 15.699 | 14.797 | 15.696 | 15.359 | 15.318 |
| 16 | 13.696 | 14.474 | 15.057 | 15.47 | 14.557 | 15.466 | 15.125 | 15.083 |
| 17 | 13.58 | 14.378 | 14.977 | 15.268 | 14.344 | 15.263 | 14.919 | 14.876 |
| 18 | 13.478 | 14.293 | 14.905 | 15.089 | 14.156 | 15.083 | 14.736 | 14.691 |
| 19 | 13.386 | 14.217 | 14.841 | 14.928 | 13.987 | 14.922 | 14.572 | 14.526 |
| 20 | 13.303 | 14.149 | 14.783 | 14.783 | 13.835 | 14.777 | 14.424 | 14.377 |
| 21 | 13.228 | 14.086 | 14.731 | 14.663 | 13.706 | 14.656 | 14.3 | 14.252 |
| 22 | 13.159 | 14.029 | 14.683 | 14.553 | 13.589 | 14.546 | 14.187 | 14.138 |
| 23 | 13.096 | 13.977 | 14.64 | 14.453 | 13.482 | 14.445 | 14.084 | 14.035 |
| 24 | 13.038 | 13.93 | 14.6 | 14.361 | 13.384 | 14.353 | 13.99 | 13.939 |
| 25 | 12.984 | 13.886 | 14.563 | 14.276 | 13.294 | 14.268 | 13.903 | 13.852 |
| 26 | 12.935 | 13.845 | 14.529 | 14.224 | 13.235 | 14.216 | 13.848 | 13.796 |
| 27 | 12.891 | 13.808 | 14.498 | 14.176 | 13.18 | 14.167 | 13.797 | 13.744 |
| 28 | 12.85 | 13.774 | 14.469 | 14.131 | 13.129 | 14.122 | 13.75 | 13.696 |
| 29 | 13.721 | 13.742 | 14.442 | 14.089 | 13.082 | 14.08 | 13.706 | 13.652 |
| 30 | 12.775 | 13.712 | 14.417 | 14.051 | 13.038 | 14.041 | 13.665 | 13.61 |
| 31 | 12.762 | 13.706 | 14.416 | 14.056 | 13.035 | 14.046 | 13.667 | 13.611 |
| 32 | 12.759 | 13.71 | 14.425 | 14.06 | 13.033 | 14.05 | 13.669 | 13.613 |
| 33 | 12.756 | 13.714 | 14.434 | 14.065 | 13.031 | 14.054 | 13.671 | 13.614 |
| 34 | 12.754 | 13.717 | 14.442 | 14.069 | 13.029 | 14.058 | 13.673 | 13.615 |
| 35 | 12.754 | 13.723 | 14.452 | 14.073 | 13.027 | 14.062 | 13.674 | 13.616 |
| 36 | 12.827 | 13.807 | 14.545 | 14.164 | 13.107 | 14.152 | 13.761 | 13.701 |
| 37 | 12.896 | 13.887 | 14.632 | 14.25 | 13.181 | 14.238 | 13.842 | 13.782 |
| 38 | 12.961 | 13.962 | 14.715 | 14.332 | 13.252 | 14.319 | 13.92 | 13.858 |
| 39 | 13.023 | 14.033 | 14.793 | 14.409 | 13.32 | 14.396 | 13.993 | 13.931 |
| 40 | 13.093 | 14.112 | 14.879 | 14.482 | 13.384 | 14.47 | 14.063 | 14 |
| 41 | 13.17 | 14.198 | 14.971 | 14.574 | 13.465 | 14.561 | 14.15 | 14.087 |
| 42 | 13.243 | 14.279 | 15.059 | 14.66 | 13.543 | 14.647 | 14.234 | 14.169 |
| 43 | 13.313 | 14.357 | 15.143 | 14.743 | 13.618 | 14.73 | 14.313 | 14.248 |

**Interim Year (2015)**
**Carbon Monoxide**

| Avg. Speed | Rural Int. | Urban Int. | Freeway | U Prin Art | R Prin Art | U Minor Art | R Minor Art | Collectors |
|---|---|---|---|---|---|---|---|---|
| 44 | 13.381 | 14.433 | 15.224 | 14.822 | 13.689 | 14.809 | 14.389 | 14.323 |
| 45 | 13.466 | 14.524 | 15.321 | 14.898 | 13.756 | 14.884 | 14.462 | 14.395 |
| 46 | 13.546 | 14.611 | 15.413 | 14.989 | 13.841 | 14.975 | 14.55 | 14.484 |
| 47 | 13.624 | 14.695 | 15.501 | 15.077 | 13.922 | 15.063 | 14.635 | 14.568 |
| 48 | 13.698 | 14.775 | 15.586 | 15.161 | 13.999 | 15.147 | 14.717 | 14.649 |
| 49 | 13.784 | 14.866 | 15.681 | 15.242 | 14.074 | 15.227 | 14.795 | 14.727 |
| 50 | 13.872 | 14.959 | 15.777 | 15.319 | 14.145 | 15.304 | 14.87 | 14.801 |
| 51 | 13.957 | 15.049 | 15.87 | 15.411 | 14.232 | 15.396 | 14.96 | 14.891 |
| 52 | 14.039 | 15.135 | 15.959 | 15.5 | 14.316 | 15.485 | 15.047 | 14.978 |
| 53 | 14.13 | 15.228 | 16.054 | 15.585 | 14.397 | 15.57 | 15.131 | 15.061 |
| 54 | 14.23 | 15.329 | 16.156 | 15.667 | 14.475 | 15.652 | 15.211 | 15.141 |
| 55 | 14.327 | 15.427 | 16.254 | 15.746 | 14.55 | 15.731 | 15.289 | 15.218 |
| 56 | 14.421 | 15.521 | 16.348 | 15.842 | 14.644 | 15.828 | 15.384 | 15.315 |
| 57 | 14.52 | 15.619 | 16.445 | 15.935 | 14.734 | 15.922 | 15.477 | 15.409 |
| 58 | 14.632 | 15.727 | 16.551 | 16.024 | 14.822 | 16.012 | 15.566 | 15.499 |
| 59 | 14.74 | 15.832 | 16.653 | 16.111 | 14.906 | 16.099 | 15.652 | 15.587 |
| 60 | 14.845 | 15.934 | 16.752 | 16.195 | 14.988 | 16.184 | 15.735 | 15.671 |
| 61 | 14.919 | 16.006 | 16.822 | 16.292 | 15.087 | 16.282 | 15.834 | 15.772 |
| 62 | 14.919 | 16.006 | 16.822 | 16.386 | 15.183 | 16.377 | 15.929 | 15.869 |
| 63 | 14.919 | 16.006 | 16.822 | 16.478 | 15.276 | 16.47 | 16.022 | 15.963 |
| 64 | 14.919 | 16.006 | 16.822 | 16.566 | 15.366 | 16.559 | 16.111 | 16.054 |
| 65 | 14.919 | 16.006 | 16.822 | 16.652 | 15.453 | 16.646 | 16.198 | 16.142 |

Design Year (2026)
Carbon Monoxide

| Avg. Speed | Rural Int. | Urban Int. | Freeway | U Prin Art | R Prin Art | U Minor Art | R Minor Art | Collectors |
|---|---|---|---|---|---|---|---|---|
| 2.5 | 26.266 | 27.545 | 28.497 | 29.653 | 28.114 | 29.695 | 29.097 | 29.105 |
| 3 | 24.629 | 25.806 | 26.681 | 26.382 | 25.061 | 26.417 | 25.904 | 25.911 |
| 4 | 20.939 | 21.885 | 22.589 | 22.292 | 21.245 | 22.319 | 21.913 | 21.918 |
| 5 | 18.726 | 19.533 | 20.133 | 19.838 | 18.955 | 19.861 | 19.519 | 19.522 |
| 6 | 17.093 | 17.833 | 18.385 | 18.231 | 17.393 | 18.248 | 17.926 | 17.922 |
| 7 | 15.849 | 16.554 | 17.08 | 17.083 | 16.278 | 17.096 | 16.788 | 16.778 |
| 8 | 14.916 | 15.595 | 16.102 | 16.222 | 15.441 | 16.232 | 15.934 | 15.921 |
| 9 | 14.191 | 14.849 | 15.341 | 15.552 | 14.79 | 15.56 | 15.27 | 15.254 |
| 10 | 13.61 | 14.252 | 14.732 | 15.017 | 14.269 | 15.023 | 14.739 | 14.72 |
| 11 | 13.138 | 13.775 | 14.251 | 14.594 | 13.837 | 14.598 | 14.312 | 14.29 |
| 12 | 12.748 | 13.393 | 13.875 | 14.242 | 13.476 | 14.245 | 13.956 | 13.931 |
| 13 | 12.418 | 13.069 | 13.557 | 13.944 | 13.171 | 13.946 | 13.655 | 13.627 |
| 14 | 12.135 | 12.792 | 13.284 | 13.689 | 12.91 | 13.689 | 13.396 | 13.367 |
| 15 | 11.89 | 12.552 | 13.048 | 13.468 | 12.683 | 13.467 | 13.173 | 13.142 |
| 16 | 11.705 | 12.375 | 12.877 | 13.272 | 12.478 | 13.271 | 12.973 | 12.941 |
| 17 | 11.609 | 12.295 | 12.811 | 13.099 | 12.297 | 13.097 | 12.797 | 12.763 |
| 18 | 11.523 | 12.225 | 12.752 | 12.946 | 12.136 | 12.943 | 12.64 | 12.605 |
| 19 | 11.447 | 12.162 | 12.699 | 12.808 | 11.992 | 12.805 | 12.5 | 12.464 |
| 20 | 11.378 | 12.105 | 12.651 | 12.685 | 11.862 | 12.681 | 12.374 | 12.337 |
| 21 | 11.315 | 12.054 | 12.608 | 12.58 | 11.751 | 12.576 | 12.267 | 12.229 |
| 22 | 11.258 | 12.007 | 12.569 | 12.485 | 11.65 | 12.481 | 12.169 | 12.13 |
| 23 | 11.205 | 11.964 | 12.533 | 12.399 | 11.558 | 12.394 | 12.08 | 12.041 |
| 24 | 11.157 | 11.924 | 12.5 | 12.319 | 11.474 | 12.314 | 11.999 | 11.958 |
| 25 | 11.112 | 11.888 | 12.47 | 12.246 | 11.396 | 12.241 | 11.924 | 11.882 |
| 26 | 11.072 | 11.855 | 12.442 | 12.203 | 11.347 | 12.197 | 11.878 | 11.836 |
| 27 | 11.035 | 11.824 | 12.417 | 12.162 | 11.301 | 12.156 | 11.835 | 11.793 |
| 28 | 11.001 | 11.796 | 12.393 | 12.125 | 11.259 | 12.118 | 11.796 | 11.752 |
| 29 | 11.961 | 11.769 | 12.371 | 12.09 | 11.219 | 12.083 | 11.759 | 11.715 |
| 30 | 10.939 | 11.745 | 12.35 | 12.057 | 11.182 | 12.05 | 11.725 | 11.68 |
| 31 | 10.928 | 11.739 | 12.349 | 12.061 | 11.18 | 12.054 | 11.726 | 11.681 |
| 32 | 10.925 | 11.742 | 12.356 | 12.065 | 11.178 | 12.057 | 11.727 | 11.681 |
| 33 | 10.923 | 11.745 | 12.363 | 12.068 | 11.176 | 12.06 | 11.728 | 11.682 |
| 34 | 10.92 | 11.748 | 12.37 | 12.071 | 11.174 | 12.063 | 11.729 | 11.682 |
| 35 | 10.92 | 11.753 | 12.378 | 12.074 | 11.172 | 12.066 | 11.73 | 11.683 |
| 36 | 10.985 | 11.827 | 12.459 | 12.154 | 11.242 | 12.145 | 11.806 | 11.758 |
| 37 | 11.046 | 11.896 | 12.536 | 12.229 | 11.308 | 12.221 | 11.878 | 11.829 |
| 38 | 11.103 | 11.963 | 12.609 | 12.301 | 11.37 | 12.292 | 11.946 | 11.896 |
| 39 | 11.158 | 12.026 | 12.678 | 12.369 | 11.43 | 12.36 | 12.011 | 11.96 |
| 40 | 11.22 | 12.095 | 12.753 | 12.434 | 11.486 | 12.424 | 12.072 | 12.02 |
| 41 | 11.287 | 12.17 | 12.834 | 12.514 | 11.558 | 12.504 | 12.149 | 12.097 |
| 42 | 11.352 | 12.242 | 12.911 | 12.59 | 11.627 | 12.58 | 12.223 | 12.169 |
| 43 | 11.414 | 12.311 | 12.985 | 12.663 | 11.692 | 12.652 | 12.292 | 12.238 |

**Design Year (2026)**
**Carbon Monoxide**

| Avg. Speed | Rural Int. | Urban Int. | Freeway | U Prin Art | R Prin Art | U Minor Art | R Minor Art | Collectors |
|---|---|---|---|---|---|---|---|---|
| 44 | 11.474 | 12.377 | 13.056 | 12.732 | 11.755 | 12.722 | 12.359 | 12.305 |
| 45 | 11.548 | 12.457 | 13.141 | 12.799 | 11.814 | 12.788 | 12.423 | 12.368 |
| 46 | 11.619 | 12.534 | 13.222 | 12.879 | 11.889 | 12.868 | 12.501 | 12.445 |
| 47 | 11.687 | 12.608 | 13.3 | 12.956 | 11.96 | 12.945 | 12.576 | 12.52 |
| 48 | 11.753 | 12.678 | 13.374 | 13.03 | 12.028 | 13.019 | 12.647 | 12.591 |
| 49 | 11.828 | 12.758 | 13.458 | 13.101 | 12.093 | 13.089 | 12.716 | 12.659 |
| 50 | 11.906 | 12.84 | 13.543 | 13.169 | 12.156 | 13.157 | 12.782 | 12.725 |
| 51 | 11.981 | 12.919 | 13.624 | 13.25 | 12.233 | 13.238 | 12.861 | 12.804 |
| 52 | 12.053 | 12.994 | 13.702 | 13.327 | 12.307 | 13.316 | 12.938 | 12.88 |
| 53 | 12.133 | 13.076 | 13.786 | 13.402 | 12.378 | 13.391 | 13.011 | 12.953 |
| 54 | 12.222 | 13.166 | 13.875 | 13.474 | 12.447 | 13.463 | 13.082 | 13.023 |
| 55 | 12.308 | 13.252 | 13.961 | 13.544 | 12.513 | 13.532 | 13.15 | 13.091 |
| 56 | 12.391 | 13.335 | 14.044 | 13.629 | 12.595 | 13.618 | 13.234 | 13.177 |
| 57 | 12.478 | 13.421 | 14.13 | 13.711 | 12.675 | 13.7 | 13.316 | 13.26 |
| 58 | 12.577 | 13.517 | 14.223 | 13.789 | 12.752 | 13.78 | 13.395 | 13.34 |
| 59 | 12.673 | 13.61 | 14.313 | 13.866 | 12.827 | 13.857 | 13.471 | 13.417 |
| 60 | 12.765 | 13.699 | 14.4 | 13.94 | 12.899 | 13.932 | 13.544 | 13.492 |
| 61 | 12.831 | 13.762 | 14.461 | 14.026 | 12.987 | 14.019 | 13.632 | 13.581 |
| 62 | 12.831 | 13.762 | 14.461 | 14.109 | 13.071 | 14.103 | 13.716 | 13.667 |
| 63 | 12.831 | 13.762 | 14.461 | 14.189 | 13.153 | 14.185 | 13.798 | 13.75 |
| 64 | 12.831 | 13.762 | 14.461 | 14.268 | 13.233 | 14.264 | 13.877 | 13.831 |
| 65 | 12.831 | 13.762 | 14.461 | 14.343 | 13.31 | 14.34 | 13.953 | 13.909 |

# APPENDIX B
# CAL3QHC Model Results

# Route 460 Location Study

# AIR QUALITY
# Technical Report